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ABSTRACT

The purpose of this current research effort was to identify and validate the effectiveness of alternative learning strategies. Learners employing networking and interactive peer study substrategies achieved more than did no-treatment controls. Similarly, strategies-trained learners reported greater positive learning attitude changes than did controls. Although strategy components were perceived favorably by learners, the executive strategy (MURDER), networking, peer learning, and concentration management strategies were the most highly rated. (MURDER is an acronym standing for key words in a series of six steps in the comprehension/retention executive routine. The key words are mood, understand, recall, digest, expand, and review.) (Author/CSS)

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AIR FORCE HUMAN RESOURCES LABORATORY

SYSTEMATIC TRAINING PROGRAM FOR ENHANCING LEARNING STRATEGIES AND SKILLS: FURTHER DEVELOPMENT

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September 1978
Interim Report for Period March 1976 – March 1977

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The purpose of the current reseach effort was to identify and validate the effectiveness of alternative learning strategies. Learners employing networking and interactive peer study substrategies achieved more than did no treatment controls. Similarly, strategies trained learners reported greater positive learning attitude changes than did controls. Although strategy components were perceived favorably by learners, the executive strategy (MURDER), networking, peer learning and concentration management strategies were the most highly rated.

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SUMMARY

Purpose and Approach

Our major goal has been to develop and assess an effective learning strategy training program. We believe that such a program would be valuable in reducing training time and increasing training effectiveness in both military and civilian contexts.

Our approach has been to view the learner as engaging in a complex system of activities, each requiring a particular strategy. At this point, we have subdivided this system of activities or strategies into two categories: primary and support. Before discussing our research, we will briefly describe the goals and general approaches associated with each strategy component.

1. Primary strategies. The primary strategies are those used by the student in operating directly on the material. These include the following:

- Comprehension and retention. Our goal has been to develop a set of strategies that will assist the student in transforming and elaborating incoming material in a way that increases conceptual connectivity. It is assumed that the greater the conceptual connectivity the greater the retention. Because we feel this component is the cornerstone of the learning system we have developed and assessed three alternative comprehension/retention strategies.

- Retrieval and utilization. The goal has been to develop strategies that will assist the individual in systematically exploring his/her memory structure for information relevant to the task at hand. In addition, these strategies are designed to aid in organizing the relevant information for communication to others. Generally, the approach has been to translate effective problem solving strategies (e.g., means-ends analysis) into techniques relevant to the retrieval and utilization domain.

2. Support strategies. The support strategies are those used by the student to create and maintain an internal psychological state that is conducive to effective learning.

- Goal Setting and Scheduling. Our objective has been to assist the student in developing a hierarchy of goals: starting with career goals and proceeding downward to weekly goals. In addition, we have taught the student to create a weekly activity schedule that is compatible with his/her goals.

- Concentration Management. To help alleviate concentration problems the students are given experiences and strategies designed to assist them in becoming aware of the negative and positive emotions, self talk and images they generate in facing a learning task. Further, the students are encouraged to evaluate the constructiveness of their internal dialogue and are given heuristics for making appropriate modifications.

A second class of strategies for reducing concentration problems involves establishing and maintaining a positive learning state via relaxation and constructive self talk.

- Monitoring Strategies. The purpose of these strategies is twofold; first, they serve an executive function in that they control the onset of other components; second, they are designed to assist the student in detecting when his/her processing is not sufficient to meet task demands so that appropriate adjustments can be made.

We originally created these components based on a review of the literature and discussions with students. We subsequently conducted a series of informal pilot studies to gain experience in administering the strategies and to receive feedback upon which to base further modifications. The modified strategies were then synthesized into a 15 week (2½ hrs/week) learning strategies course.

In order to evaluate the effectiveness of the strategy system in the context of this course we created two interlocking experiments. In one the performance of differentially treated sub-groups of the class (total N=38) were compared with each other and with a no-treatment control group (the comprehension/retention controls, N=28). The bases of these comparisons were a series of measures that required the students to study textbook material for one hour (approximately 3,000 word passages) and then

take a 45 minute comprehensive test over the material one week later. These measures were given to the class members and the controls prior to the start of the course (the pretest), approximately halfway through the course (the mid-course test), and at the end of the course (the post test).

In the second experiment the performance of the class members on a set of self report measures (Test Anxiety Scale, Brown-Holtzman Survey of Study Habits and Attitudes, Concentration Questionnaire and a Learning Attitude Inventory) were compared to a no-treatment control group (N=21) both before and after the course.

Results

Analysis of the "changes" scores from the comprehension/retention "pre" test (given prior to strategy instruction) to the other two comprehension/retention tests indicated significant differences in "changes" between the class members and control subjects from the "pre" test to the "halfway" test on both the multiple choice portion and the total of the multiple choice and short answer portions. Significant differences in "changes" between the two groups were also found from the "pre" test to the "post" test on both the short answer portion and the total. In all cases the class members exhibited greater "gains" on these measures than did the no-treatment control subjects.

In terms of total score, the class members who took all three tests outscored the control group by greater percentages on the mid-course (19.9%) and post tests (18.2%) than on the pre test (3.4%). Further, it appears that the training had a stronger influence on the short answer sub-test than on the multiple choice test. On the short answer pre test the class members outscored the controls by only 8.1% while on the mid course and post tests they outscored the controls by 30.1% and 31.0%, respectively. This impact on the short answer portion was amplified in the case of certain strategy sub-groups. Students who studied in pairs for the mid-course test outscored the controls by 16.4% on the short answer pre test and by 45.4% on the mid-course test. Those individuals who learned networking as a comprehension/retention sub-strategy scored 1.2% below the controls on the short answer pre test and 42.3% higher than the controls on the post test. The relatively greater impact of training on

the short answer sub-tests is especially encouraging since compared to multiple choice exams these tests are much less likely to be influenced by guessing and differential test taking strategies.

Analyses comparing the pre to post change scores of the class members with those of the controls reached significance on three of the "self report" measures and approached significance ($p < .06$) on the fourth (the Concentration Questionnaire). In all cases the class members reported greater positive changes on academically related dimensions than did the self report controls.

Conclusions

The comprehension/retention and self-report results coupled with the positive feedback arising from the students' course evaluations indicate that the strategy system and training were impactful in constructively altering the students' learning behaviors and attitudes. Further, observations and informal evaluations made during the conduct of the course indicated a number of directions for improving both the strategies and training methods. Modifications based on these data are now being made.

PREFACE

This report documents the continuing development and assessment of a cognitively based learning strategy curriculum. The research was accomplished under Project ARPA #3204. Dr. Gerald Deignan, Air Force Human Research Laboratory at Lowry AFB, was the Project Scientist and Dr. Harold O'Neil, Advanced Research Projects Agency, was the Program Manager. Both of these individuals made extremely valuable contributions to the conduct of this research and development effort.

In addition, we wish to acknowledge the efforts and cooperation of those Texas Christian University Psychology faculty members who aided us in obtaining undergraduate psychology students to participate as control subjects.

The work reported in this document was conducted under the provisions of Contract Number MDA 903-76-C0218 with Texas Christian University, Fort Worth, Texas 76129. Dr. Donald F. Dansereau was the Principal Investigator. This research is based upon previous work reported by the contractor under Contract F41609-74-C-0013 in AFHRL-TR-75-41, Effective Learning Strategy Training Program: Development and Assessment.

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INTRODUCTION

The purpose of this report is to describe our recent work on the development and assessment of a learning strategy training program. This work represents an attempt to expand and modify a successful, small scale program developed by Dansereau, D. F., Long, G. L., McDonald, B. A., Actkinson, T. R., Ellis, A. M., Collins, K., Williams, S. & Evans, S. H. (1975).

Our approach has been strongly influenced by the fact that effective interaction with academic materials requires the learner to engage in a complex system of activities. Consequently, our goal has been to develop a set of mutually supportive strategies that the learner can modify and adopt to suit particular needs. In a sense our objective is to assist students in reprogramming their own bio-computers. At this point we are not primarily interested in assessing what students already do but rather in developing coherent strategy systems that the students can assimilate and modify in order to shore up or replace the strategies they have developed spontaneously.

Although the major purpose is to develop and assess a particular learning strategy program, another more general and perhaps more important objective is to create a framework from which applied and basic extensions can be made. What we are trying to do is form a blueprint or sketch of the prose learning and utilization system in anticipation that the details can be filled in by more fine grained empirical studies. This is a little different from the typical approach where the fine grained studies are done in anticipation of later putting the information together. Unfortunately, in most circumstances this synthesis very rarely gets accomplished.

To communicate what has been completed to date, the remainder of this report has been organized into four major sections: a description of the general approach, a discussion of the primary strategy components, a discussion of the support strategy components, and a discussion of the results arising from an implementation of the learning strategy system in the context of a college level learning skills course.

THE GENERAL APPROACH

In this section we will describe the overall strategy system and our approach to the development of strategy alternatives and training techniques.

An Overview of the Strategy System

At this point, we have subdivided the strategy system into two categories: primary and support. (See the major sections entitled: Primary strategies and Support strategies for further information.)

The primary strategies. The primary strategies are those used by the student in operating directly on the material. These include strategies for improving comprehension/retention and retrieval/ utilization.

Support strategies. No matter how effective the primary strategies are their impact on learning and utilization will be less than optimal if the internal psychological environment of the student is non-optimal. Consequently, we have attempted to develop support strategies to assist the student in developing and maintaining a good internal state. These support strategies include techniques for goal setting and scheduling, concentration management, and monitoring and diagnosing the dynamics of the learning system.

Strategy Development

Our approach in developing the primary and support strategies has included the following steps.

1. Identification of the areas of needed improvement via questionnaires and student interviews.

2. Review of the educational and psychological literature related to each area.

3. Creation of alternative strategies from the existing knowledge base.

4. Informal pilot work on individual strategies with upper level students serving as subjects.

5. Informal pilot work on the individual strategies with freshmen and sophomores.

6. Synthesis of the strategies into an interactive system.

7. Assessment of the entire system in order to determine how well the individual strategies blend together.

Strategy Training

The communication and training of learning strategies is extremely difficult; especially when working with adults. By the time students have reached college-age most of them have deeply ingrained reactions to learning. They not only have well practiced approaches to learning tasks, but strong emotional and motivational responses as well. Further, in most cases the students have little awareness of the rationale behind their habitual ways of responding to learning situations.

This state of affairs leads to a number of difficult problems.

1. Because most of the students have a large prior investment in their learning methods (14 or more years of practice in most cases) they are very reluctant to change (especially without a guarantee of greatly improved learning performance).

2. Many students have such strong conflicting emotional and motivational reactions to learning that they find it difficult to receive communications related to this topic.

3. Even if a student decides to alter his/her strategies the process of breaking old habits is difficult and time consuming. Although many students feel the need to change, relatively few are willing to make the necessary effort.

4. During the period when the student is incorporating the new strategies into his/her existing system performance may in fact be disrupted. This disruption, which may be caused by the student trying to use partially learned techniques, can serve to further discourage

strategy adoption.

We have been exploring a number of ways to overcome these problems. These explorations have led us to breakdown the training on each strategy component into the following six different classes of activity:

1. Stimulation and awareness--Prior to instruction on each component the student is given a brief experience to illustrate the importance and potential impact of what is to come. This experience (e.g., simple peg word mnemonic instructions as practice for the comprehension/retention component) is designed to enhance motivation, involvement, and cognitive awareness.

2. Conceptual level information--This information provides psychological and educational background for the actual strategy instruction. The interrelationships between the components are presented at this time in order to increase the student's cognitive awareness and his/her perception of the validity of the program. Taken together, materials at this level form a mini cognitive psychology course which should give the student the intellectual foundations for the strategies which follow.

3. Strategy instruction--Material at this level describes procedures for actually applying the strategy. Preliminary exercises are provided at this time.

4. Strategy application--The student is given guided practice on applying each strategy to learning the conceptual and instructional (2 and 3 above) level materials associated with subsequent strategies. In effect, as students progress through the training program, they are gradually increasing their strategy repertoire and are using this increasing repertoire in learning new strategy information.

5. Feedback on strategy application--To give students a basis for modifying their strategies they are provided with instructor generated protocols that illustrate correct strategy usage and point out potential pitfalls. This feedback is supplemented by having the students discuss the application of their strategies with their peers, thereby making use of their pooled

knowledge as well as the beneficial effects of social reinforcement and feedback. In this regard, student reactions have indicated that learning dyads (pairs of students) have a great deal of potential in facilitating strategy training.

6. Assessment and Diagnostic--Activities at this level include tests of comprehension and retention which make use of questions at the factual, conceptual, and inferential levels of understanding. These are supplemented by subjective reports of effectiveness, understanding, retention, concentration, etc. These measures provide a basis for additional feedback to the students (via self scoring, instructor intervention, and/or group discussion) and a basis for evaluating the effects of the training program components.

PRIMARY STRATEGIES

As stated earlier the primary strategies are used to operate directly on the material and at this point consist of techniques for comprehension/retention and retrieval/utilization. We will discuss our work with these two sets of strategies separately.

Comprehension/Retention

Our goal has been to develop strategies that will assist the student in creatively re-organizing, integrating and elaborating incoming material in order to increase conceptual connectivity in a manner that is compatible with long term memory structures. The premise is that the more connections or relationships between concepts, objects, ideas or actions that individuals discover or create the deeper their understanding, the greater their retention and the more likely they will be able to retrieve the material under a variety of circumstances.

To reach this goal we have developed an "executive" strategy (this is analogous to the computer programming concept of an executive routine) and a variety of alternative sub-strategies. We will discuss our work with these strategies in the following sections.

The "executive" comprehension/retention strategy. This strategy involves four overlapping steps:

1. The student reads a portion of the text material to acquire the main ideas (the "understanding" phase). During this phase the student is encouraged to mark difficult and important parts of the material.

2. He/she then recalls what has been read without referring to the text (the "recall" phase). Three alternative approaches to this recall process have been developed and these will be discussed in the next section.

3. Following recall the student goes back through the text material correcting understanding problems, amplifying the recalled material, and storing important information (the "digest" phase).

4. The student then attempts to expand his/her knowledge by self inquiry (e.g., "How can I use this information in a job situation?", "How would I teach this material to a lower level student?"). This has been termed the "expand" phase. Generally, the students are encouraged to use this executive strategy flexibly and to tailor it to their own style and capabilities. The four steps in this strategy are supplemented by an initial "mood" or state setting phase (a support strategy which will be discussed later) and a "review" stage (based on a "How to learn from a test" procedure, See Dansereau, Collins, McDonald, Diekhoff, Garland, and Holley for further information on this procedure, 1978). These six steps form an overall study "executive." The acronym MURDER has been used as a label for this strategy in order to facilitate its retention (see Appendix A for further description).

The four basic comprehension/retention steps (understand, recall, digest, and expand) described earlier are similar to the processes suggested by the SQ3R technique (Robinson, 1946) and some of its derivatives. These approaches all have two important aspects in common. First, the student is encouraged to process the same text material more than once (a multiple pass approach). Second, a great deal of emphasis is placed on the active recall or recitation of what has been learned.

The potential effectiveness of multiple passes has been supported by experiments with advanced organizers. Ausubel and his associates (e.g., Ausubel, 1960; Ausubel and Fitzgerald, 1962) have found that providing a summary of the material before reading increases comprehension and retention performance. In the executive strategy and the SQ3R techniques the student creates his/her own implicit advanced organizer on the first reading and then uses this information on a second pass through the material. Additional support for this approach arises from Norman, Genter, and Stevens' (1976) suggestions regarding the effectiveness of "web" learning. They contend that complicated material may be learned in successive passes. The first pass would presumably create a web or network of the important concepts while subsequent processings of the material would allow the individual to fill in the details.

Generally, the "recall" phase of the executive strategy and the SQ3R techniques forces the student to actively process the information by putting the text material into an alternate form (the student's own words or images or an alternative symbol system). In addition, this process points out weaknesses in the student's understanding and retention which can be corrected on a second pass through the material. The importance of active recall in improving comprehension and retention has been directly supported by the experiments of Del Giorno, Jenkins and Bausell (1974) and Dansereau et al (1975), and indirectly supported by the work of Rothkopf (1966) and Craik and Lockhart (1972).

Although varying somewhat in surface structure, the main differences between our executive strategy and the SQ3R approaches occurs in the details of the steps. Typically training on SQ3R is non-specific; the steps are described and the students are expected to translate these descriptions into operative sub-strategies. Our work has indicated that a large number of students have a great deal of difficulty in making this translation. To alleviate this problem we have designed detailed instructions and practice exercises to communicate alternative sub-strategies that fall under the "executive" framework. In the next sections we will briefly describe the nature of these sub-strategies.

The comprehension problem solving strategy. While the students are doing their first reading they are encouraged to mark the portions of the text that they do not understand. During the "digest" phase they are instructed to "home in" on the marked portions that are still not understood (some understanding problems are naturally cleared up by further reading). The student is trained first to identify the nature and extent of the comprehension (understanding) problem (i.e., is it a problematic word, sentence or paragraph) and is then trained to attack the problem by breaking it down into its parts (e.g., prefix and suffix in the case of a word or subject/predicate in the case of a sentence). If the student is still unsure of the meaning, he/she is encouraged to look in other parts of the passage (the "surround") in order to find related information (e.g., synonyms and redundant explanations). If there are still difficulties, the student is instructed to consult another source (e.g., a dictionary, teacher or another textbook). The main thrust of this strategy is to put the student into the role of an active problem solver rather than passive recipient of information.

The "recall" and transformation strategies. After an initial reading the student is instructed to recall the material he/she has read. We feel that this is the most important phase of the executive comprehension/retention strategy and consequently we have developed a number of sub-strategies that vary in the degree of transformation (translation of the text into an alternative symbol system) required on the part of the student.

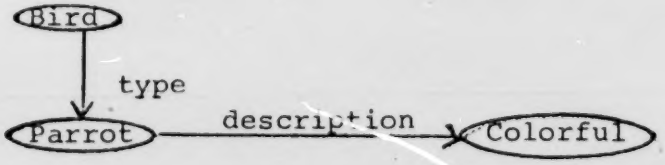
We have explored three alternative techniques: paraphrase/imagery, networking and analysis of key concepts. We will describe each of these techniques separagely.

1. Paraphrase/imagery. This technique is a simple combination of the paraphrase (the student intermittently rephrases the incoming material in his/her own words) and imagery (the student intermittently forms mental pictures of the concepts underlying the incoming material) strategies developed in our initial program (see Dansereau et al., 1975). The student is trained on both techniques and is then

instructed to vary his/her use of the techniques depending on the material being studied. In an earlier study we found that both techniques led to improved performance on a delayed essay test in comparison to a no treatment control group (Dansereau et al., 1975).

2. Networking. Unlike the paraphrase/imagery technique which requires the student to transform text material into natural language or pictures, the networking strategy requires material to be transformed into node-link maps or networks. Before giving more information on the technique per se we will present some general background information on the concept of node-link networks.

Quillian (1969) suggested that human memory may in fact be organized as a network composed of ideas or concepts (nodes) and the named relationships between these concepts (links). For example, the relationships (links) between the concepts (nodes) bird, parrot, and colorful can be expressed as: "A parrot is a type of bird" and "a parrot can be described as colorful." These node-link relationships can be represented spatially in the following network:



Since Quillian's early work a number of network models of memory have been proposed and tested (e.g., Rumelhart, Lindsay and Norman, 1972; Anderson, 1972; Anderson and Bower, 1973). The results of these efforts indicate that at least some aspects of human memory can be functionally represented as networks. For this and a number of other reasons which we will discuss shortly, the node-link network was chosen as the basis for two of our recall-transformation techniques (as you will see the analysis of key concepts technique is also based on this conceptualization).

The networking strategy requires the student to identify important concepts or ideas (nodes) in the material and to represent their interrelationships (links) in the form of a network map. To assist the student in this endeavor he/she is taught a set of named links that can be used to code the relationships between ideas. Up to this point we have been working with two sets of links which we derived by examining the relationships expressed in a wide range of text material. The simpler set is composed of four relationships: type (e.g., a dog is a type of animal), part (e.g., the hand is a part of the body), leads to (e.g., reinforcement leads to repetition of the reinforced behavior), and description (e.g., the male peacock can be described as colorful). Figure 1 shows the symbology associated with these relationships and Figure 2 illustrates a network derived from a paragraph using this four link system.

The details of the more complicated link system are beyond the scope of this paper. It is sufficient to say that this system is composed of 13 types of links which expand on the four classes of links just described (e.g., "leads to" links are replaced by "cause," "influence," and "solve" links). In other respects this system is used in much the same fashion as the four link system.

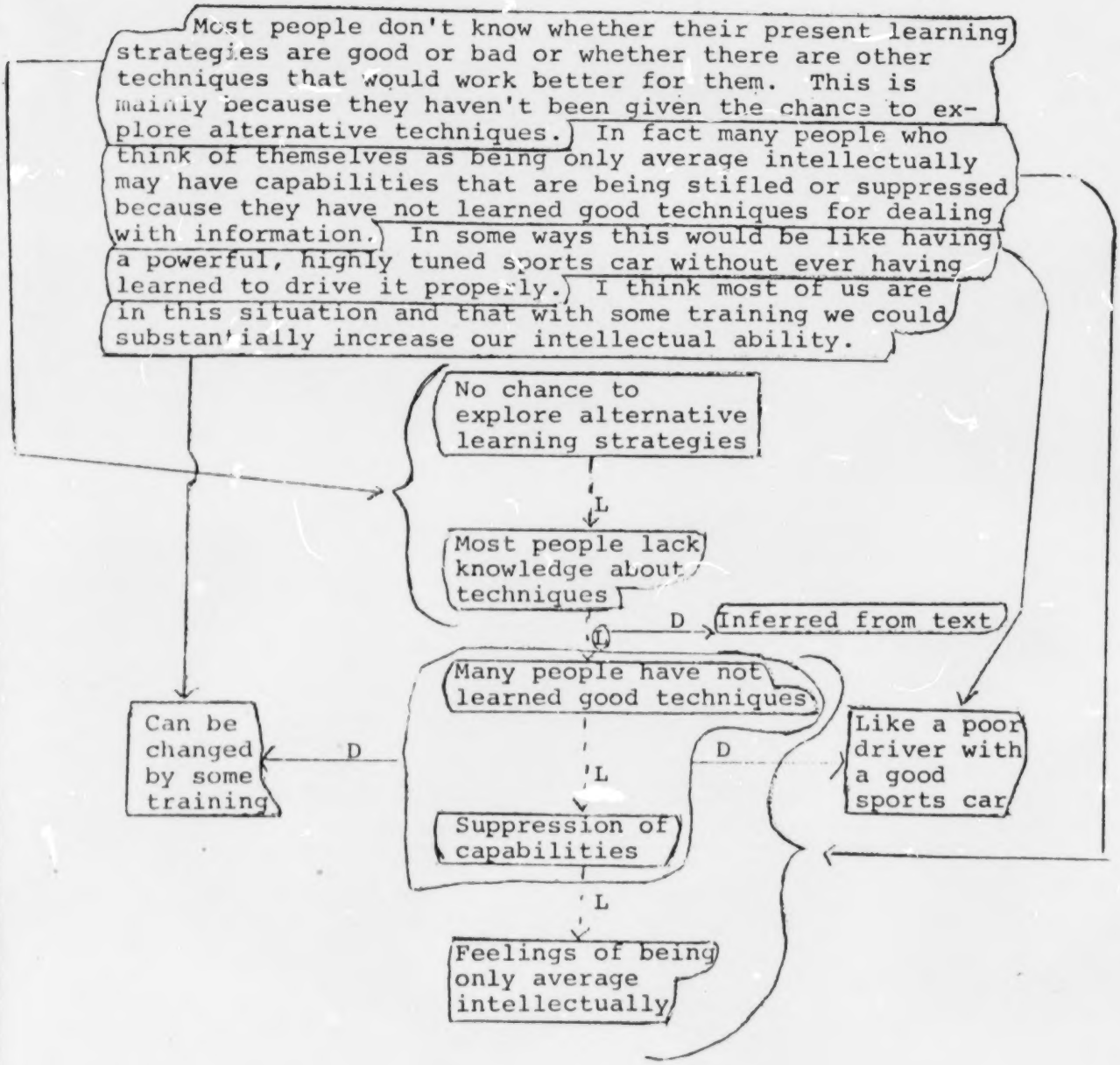
We believe that the transformation of prose into a network will assist the student in seeing the overall picture being presented by the author. In addition, having coded the material in terms of named links gives the student the option of using these links to gain access to the material during retrieval (this possibility will be discussed further in the section on recall/utilization). Besides these direct benefits, an expanded network approach appears to have applicability to a number of other domains.

From the teacher's perspective networking can be used in the preparation of lectures as an alternative to outlining. Also, teacher prepared networks can be presented as advanced and post organizers. Additional benefits may be derived from using networks in teaching students who are employing networking as a learning strategy.

Link Name	Symbolic Representation	Example
Leads to	Object, Action or Concept → (L) → Object, Action or Concept	Fear of Failure → (L) → Studying ("Fear of failure leads to studying.")
Part	Object, Action or Concept → (P) → Part of Object, Action or Concept	Hand → (P) → Fingers ("Fingers are a part of the hand.")
Type/Example	Class of Category of Objects, Actions or Concepts → (T) → Member or Example of the Class or Category	Feline → (T) → Cheetah ("A Cheetah is a type of Feline.")
Description	Object, Action or Concept → (D) → Description	Male Parakeet → (D) → Blue patch on beak ("A male parakeet has a blue patch on his beak.")

The Four Link System

FIGURE 1


Most people don't know whether their present learning strategies are good or bad or whether there are other techniques that would work better for them. This is mainly because they haven't been given the chance to explore alternative techniques. In fact many people who think of themselves as being only average intellectually may have capabilities that are being stifled or suppressed because they have not learned good techniques for dealing with information. In some ways this would be like having a powerful, highly tuned sports car without ever having learned to drive it properly. I think most of us are in this situation and that with some training we could substantially increase our intellectual ability.
No chance to explore alternative learning strategies
L
Most people lack knowledge about techniques
D
Inferred from text
Many people have not learned good techniques
D
Can be changed by some training
D
Like a poor driver with a good sports car
L
Suppression of capabilities
L
Feelings of being only average intellectually

Transformation of a Paragraph into a Network

FIGURE 2

Networking can be used to facilitate individual and group problem solving by providing a mechanism for systematically organizing and manipulating elements within the problem space. This approach has been used in the context of a graduate psychology seminar at Texas Christian University. Subjective reactions to the approach indicate that it has substantial promise as a problem solving tool.

Conceptually it seems reasonable to expect that ability to network (i.e., discover and organize meaningful relationships between ideas, objects and actions) should be related to general reading comprehension ability. If this expectation is borne out, networking may serve as an alternative assessment and diagnostic device. In fact, the noun phrases in a body of text can be replaced by nonmeaningful symbols. A student's ability to network this material would seem to reflect a type of comprehension skill that is separable from vocabulary level and prior knowledge.

Finally, the ease and/or accuracy with which a text can be networked may provide a more valid index of comprehensibility (readability) than is presently available.

3. Analysis of key concepts. The final comprehension/retention strategy is also derived from network models of memory (Diekhoff, 1977). In this structured alternative to networking the student identifies key ideas or concepts in a body of text, develops systematic definitions and elaborations of the concepts, and interrelates important pairs of these concepts. The student is aided in these activities by worksheets which specify categories of definition and comparison. These categories are isomorphic to the four links described earlier (e.g., in defining operant conditioning one might say that it is a type of learning paradigm, a part of many behavior modification programs, leads to increases in the target behavior, etc.).

Eventually we hope to have students either use these three recall/transformation strategies in concert (i.e., have them learn all three and use each when applicable) or to use a particular strategy depending on their aptitudes, styles, and preferences.

The "expansion" strategy. After the students have gone back through the text material correcting understanding problems, amplifying the recalled material and storing important information, they are encouraged to expand their knowledge via self inquiry. In this regard, students are trained to ask and answer specific questions falling under three general categories:

1. Imagine you could talk to the author; what would you ask him/her? What criticisms would you raise?

2. How can the material be applied?

3. How could you make the material more understandable and interesting to other students?

In the initial stages of training students are required to put their answers on worksheets and are given experimenter generated questions and answers as feedback. After this initial experience the students are encouraged to do these processes "in their heads" or to incorporate the material into their ongoing notes.

In summary, the comprehension/retention techniques include an executive strategy which guides the onset of sets of substrategies designed to assist the student in solving comprehension problems, recalling and transforming learned material, and expanding his/her knowledge. These strategies, especially those dealing with recall and transformation, are closely related to the retrieval/utilization strategies which will be discussed in the next section.

Retrieval/Utilization Strategies

After comprehending and storing a body of information the student's job is only partly completed. The student must be able to recall and use the information under appropriate circumstances (i.e., in taking tests or on the job).

Subjective reports from students and studies demonstrating "tip of the tongue" behavior (Brown & McNeil, 1966), and "feeling of knowing" (Hart, 1965) indicate that stored items are frequently available, but at least temporarily, not accessible. When an individual encounters such a situation he/she may give up, randomly search, or attempt to execute a systematic

retrieval strategy. It appears that students often opt for the first two alternatives rather than the third. This practice is unfortunate in that systematic attempts at retrieval often lead to success. Lindsay and Norman (1972) give a brief example of how the systematic approach works. In response to the query: "What were you doing on Monday afternoon in the third week of September two years ago?", Lindsay and Norman's imaginary subject gradually homes in on the answer by breaking the query down into a rational sequence of subquestions that prove answerable by various mixtures of actual memories and logical reconstructions of what must have been ("Third week in September--that's just after summer--that would have been the fall term...I think I had chemistry lab on Mondays...I remember he started off with the atomic table...,etc.").

It is felt that students can benefit from instruction on how to undertake a systematic retrieval of this sort. Toward this end we have developed an executive strategy with alternative sub-strategies based on the specific comprehension/retention technique being used by the student.

The "executive" retrieval/utilization strategy. At present this strategy consists of five steps:

1. The student analyzes the task or situation to determine what is required (the "understanding" phase)

2. He/she the recalls the main ideas that are relevant to meeting the task requirements (the "recall" phase).

3. Following the recall, the student is encouraged to retrieve specific information associated with these main ideas (the "detail" phase).

4. The student then organizes this body of information and expands it into an outline (the "expand" phase).

5. From the outline the student creates a response and reviews the adequacy of this response in light of the task requirements (the "response" and "review" phase).

An initial "mood" or state setting phase is also included in this strategy (this will be discussed in the section on support strategies). Taken together these six steps are given the acronym "2nd degree MURDER" in order to facilitate retention of the technique.

Although this strategy has been designed primarily for test taking and paper preparation, extension of the technique to other tasks should be relatively straightforward.

The primary aim of the "executive" strategy is to encourage the student to view recall and utilization as a multiple pass process. Discussions with students indicate that when faced with an essay test question, for example, many of them begin writing almost immediately. This approach forces the student to recall, organize, and transform the ideas into prose simultaneously. As a result their answers are often jumbled and incomplete. The "executive" strategy is designed to help the student guard against this situation by forcing him/her to slow down and break the process into coherent steps.

In the next five sections we will discuss each of the steps (excluding the mood setting phase) in somewhat greater detail. Our goal has been to create redundant and synergic strategies. Consequently, we have designed comprehension/retention strategies that can be used during retrieval/utilization. This redundancy will become clearer in the next few sections.

The "understanding" phase. If the task requirements are not understood, the subsequent actions a student takes will be irrelevant. To assist students in this phase we encourage them to use their comprehension/retention strategies on the task instructions (e.g., test questions). For example, in preparing to answer a test question they would read the question, transform it into an alternative symbol system (i.e., a paraphrase or image, a network , or a set of defined key concepts depending on their strategy preference), and then use the comprehension problem solving techniques (i.e., "breakdown" and "surround") to clear up any understanding difficulties.

The "recall" phase. The goal of this phase is to arrive at the set of main ideas necessary to meet the task requirements. To meet this goal the student is instructed to relax and image the situation in which he/she may have acquired the target information. In addition, the student is made aware of the ties between retrieval strategies and the processes involved in problem solving (both require a search through a problem space). In particular, the student is instructed on means-ends analysis (setting and meeting sub-goals) and planning (abstracting the problem to a more general level), two key components of the General Problem Solver created by Newell, Simon, and Shaw (1958). The idea is to examine the difference between your present state of knowledge and your goal state in order to set up reasonable sub-goals. Acquisition of these sub-goals presumably lead you closer and closer to your target state of knowledge. For example, if one were trying to remember who was the Vice President of the United States in 1877, a reasonable first sub-goal might be to determine who was the President during this time period. If this information was not immediately retrievable, the next step might be to set up the sub-goal of trying to remember which major events took place during the latter 1870's. This process would continue until an achievable sub-goal was reached, then this information would be used to access the previous sub-goal, and so on. In this way one would work back up the chain of sub-goals to the target. In using the "planning" heuristic you would first generalize the retrieval task to a simpler one, solve the simple retrieval via means-ends analysis, and then use this solution as a plan to guide the more specific retrieval. For example, if you were trying to recall the location and function of a particular part of a cat's brain (e.g., the hypothalamus), you might first attempt to remember the location and function of the hypothalamus in mammals in general and then use these retrieval steps to guide the more specific inquiry.

Those students who have learned networking or the key concept technique can use the named links (relationships) as a language for exploring their memory systems. For example, is the information I am looking for embedded in a leads to chain?, is it part of a larger concept?,

is it an example or type of a more general notion?, etc. This language provides a systematic way of moving from one point in the memory system to another. In some sense it serves the role of a general purpose mnemonic technique.

The "detail" phase. Once the main ideas are recalled the same techniques discussed in the previous section can be used to retrieve the details associated with these ideas.

The "expand" phase. In this stage the student organizes the information he/she has retrieved during the previous two stages. This may involve numbering the main ideas and the associated details to produce a coherent sequence from which to construct a response. If necessary a formal outline may be created. In organizing this material the students may discover gaps in their information that need to be filled in by further retrievals.

The "respond" and "review" phase. This step requires the student to transform the recalled information into prose or a set of actions. Following this conversion the student is encouraged to examine his/her response in light of the task requirements. Modifications are made if necessary.

SUPPOI STRATEGIES

As stated earlier, no matter how effective the primary strategies are their impact on learning and utilization will be less than optimal if the internal psychological environment of the student is non-optimal. Consequently, the support strategies are designed to assist the student in developing and maintaining a good internal state. These support strategies include goal setting and scheduling, concentration management, and monitoring and diagnosing the dynamics of the learning system. These three classes of strategies will be discussed separately.

Goal Setting and Scheduling.

Goals and schedules can be viewed from a hierarchical perspective. For example, a student's daily goals (e.g., read chapter 9 in the Physics text) are embedded in a set of weekly goals (e.g., prepare for the Physics mid-term exam) which are in turn embedded in a set of semester goals (e.g., make an A in the Physics course), etc. A companion example could be created for daily, weekly and semester time schedules. Unfortunately, our discussions with students indicate that very few of them create goals and schedules in accord with this hierarchical perspective. In fact, students apparently spend very little effort of anv sort on systematic planning.

This lack of planning has a number of drawbacks:

1. Without concrete goals (especially short term goals) the student will have a difficult time gauging the adequacy of his/her progress.

2. If the student has not analyzed required tasks into subgoals, there is a strong possibility that the magnitude of the task will be mis-perceived. Some individuals view amorphous tasks optimistically and consequently do not budget sufficient time. Others view such tasks pessimistically and become very anxious about accomplishing them.

3. If goals and schedules are not written down, the student must keep this information in his/her "head." Certainly this state of affairs will act as a drain on the student's cognitive capacity.

4. A student who does not regularly schedule his/her study sessions can not make use of the positive stimulus cue values associated with a consistent schedule.

To assist students in overcoming these problems we have developed a workbook for specifying concrete goals and time schedules. In using this workbook the students first are given guidance on specifying career goals. They then determine skill-oriented sub-goals that are pre-requisites for their chosen career goals.

Following this they set concrete goals for the particular semester. Finally, in light of these goals they create a weekly activity schedule. The students are then instructed to monitor their progress in achieving their goals. If progress is not as predicted they are encouraged to alter their activity schedule or re-structure their set of goals.

Concentration Management

The most common student complaints usually revolve around their inability to concentrate during a study or testing session. We feel that these concentration difficulties stem from two general sources: attitude (or mood) problems and problems in coping with distractions. Even though we have not treated the two independently in our training programs, we will discuss them separately in order to make our conceptualizations clear.

Strategies for cultivating a positive learning attitude. Interviews and discussions with students indicate that many of them have conflicting attitudes about learning. At a distance they view learning as something that is necessary and desirable. However, when faced with an impending learning task they often experience a variety of negative emotions. Anxiety, anger, guilt, fear and frustration are some of the labels they use in conjunction with these emotions. These feelings and the self-talk and images that accompany them serve to decrease a student's motivation to study and act as distractors during the learning process and during evaluation periods.

The strategy we are developing to assist the student in overcoming attitude problems consists of a combination of elements from systematic desensitization (Jacobsen, 1938; Wolpe, 1969), rational behavior therapy (Maultsby, 1971, Ellis, 1963), and therapies based on positive self-talk (Meichenbaum and Turk, 1975; Meichenbaum and Goodman, 1971). The students are first given experiences and strategies designed to assist them in becoming aware of the negative and positive emotions, self-talk and images that they generate in facing a learning task. The vehicles for this first step are a short lecture, worksheets and samples of attitudes and self-talk expressed by students in earlier studies. After

this first step the student is asked to follow the negative feelings and thoughts to their logical conclusions (e.g., "Just what will happen if I fail this exam?"). Very often the individual has not thought beyond the fact that a particular outcome will be "awful" or that such and such an outcome is "critical" (Maultsby, 1971). Stopping at this stage can be very illusory and may lead to emotions being blown out of proportion. In addition, the accompanying self-talk and imagery may be extremely destructive when viewed in relationship to the student's long term goals. To assist the students in matching their self-talk with their objectives, they are asked to evaluate the constructiveness of their internal dialogue and are given heuristics for making appropriate modifications (worksheets and experimenter-generated sample statements are used to assist the student in this task).

In preparing for an impending study session students report that they usually spend very little conscious effort in establishing a positive learning or test taking state. It seems very likely that thoughts and feelings associated with their immediately previous situation will mix with negative cognitions about learning and will be carried over as distractors during task performance. To alleviate this situation the student is trained on a technique that forms the basis of systematic desensitization: imagination of the anxiety evoking situation during relaxation. In effect, the student is instructed to relax and "clear his/her mind" by counting breaths, then the individual imagines a period of successful studying, becoming distracted and successfully coping with the distraction. The student is also encouraged to replace the negative talk and images with more constructive thoughts. This technique forms the mood setting phase of the two MURDER processes described earlier.

Our experience with these strategies to date is that college freshman and sophomores find them relatively easy to grasp and apply. Subjective reactions to this approach have been positive.

Concentration: Coping with internal and external distractions. Interviews with students indicate that acts of will and fear arousing self-talk are the most common methods of coping with distractions, frustration

and fatigue. Apparently these methods are at best only partially effective and tend to put the student under considerable tension. This tension probably contributes to subsequent negative feelings about future learning episodes.

We have been developing concentration enhancing strategies to supplement or substitute for those typically used. Again, the first step involves awareness training: The students are given experiences and techniques to assist them in determining when, how and why they get distracted, the duration of their distraction periods and their typical reactions to distraction. They are then trained to cope with distractions by using the "attitude" strategies of relaxation and positive self-talk and imagery to re-establish an appropriate learning state. (The training methods are analogous to those discussed in the previous section).

Monitoring

To be effective, students must be able to detect when their behavior is not sufficient to meet task demands so that they can make appropriate adjustments. We have not treated monitoring as a separate component, but have embedded monitoring principles in the concentration management component and the two MURDER strategies.

In the concentration management component the students are encouraged to skim the material to be studied and mark places in the text where they plan to check progress and take "action." They read to the first "action" point and evaluate their learning state (i.e., concentration and level of understanding). If the "state" is not satisfactory they attempt to correct the situation via relaxation, constructive self-talk and imagery (i.e., the same techniques used in establishing the original learning state or mood).

In using the comprehension/retention MURDER strategy the students are encouraged to check their learning "state" after each recall. In this case, the students can evaluate the completeness of their recall as one measure of their progress. This additional information should assist the students in accurately judging the adequacy of their learning state for the task at hand.

ASSESSMENT OF THE STRATEGIES AND TRAINING METHODS IN THE CONTEXT OF A LEARNING STRATEGIES COURSE

As stated earlier, we believe that learning involves a system of interactive tasks. Consequently, we feel that a positively interactive set of strategies is required to maximize learning potential. In order to examine and capitalize on these interactions students must be taught large portions of the strategy system. Unfortunately the time and student motivation required for training precludes exploring this system in the context of typical short term experiments. Therefore, we modified the component strategies based on feedback from a series of informal pilot studies and put them together to form the basis of a one semester (15 week) learning strategies course. This 2 credit hour course was offered to Texas Christian University undergraduates during the 1977 Spring semester on a pass/no credit basis. It was felt that a course of this type would attract students with characteristics similar to those exhibited by individuals in technical training settings.

Design

In order to evaluate the effectiveness of the strategy system we created two interlocking experiments. In one the performance of differentially treated sub-groups of the class were compared with each other and with a no-treatment control group (the comprehension/retention controls). The bases of these comparisons were a series of measures that required the students to study textbook material for 1 hour (approximately 3,000 word passages) and then take a 45 minute comprehensive test (consisting of multiple choice and short answer questions) over the material one week later. These measures were given to the class members and the control group prior to the start of the course (the pre test), approximately halfway through the course (the mid-course test), and at the end of the course (the post test).

In the second experiment the performance of the class members on a set of self report measures was compared to a separate no-treatment control group (the self-report controls) both before and after the course.

Participants

The learning strategies class was composed of a heterogeneous group (with respect to grade level and majors) of 38 Texas Christian University undergraduates. They received 2 semester hours of college credit for successfully completing this pass/no credit course.

The "comprehension/retention" control group consisted of 28 students who were recruited from General Psychology classes. They fulfilled an experimental credit requirement and received a $6.00 fee for their participation.

Finally, the "subjective report" control group was composed of 21 students also recruited from General Psychology. In addition to fulfilling an experimental credit requirement, they received a $4.00 fee for participating.

Dependent Measures

The comprehension/retention measures and self report measures will be described separately.

Comprehension/retention measures. Multiple choice and short answer tests were developed for three 3,000 word passages: one extracted from a textbook on educational psychology (the pre test), one from a text on ecology (the mid-course test), and one from a text on geology (the post test). The students were given one hour to study each of these passages and then one week later given forty-five minutes to take the corresponding tests.

Self report measures. These included: a thirty-seven item test anxiety scale, (a slightly modified version of the one used by Sarason, 1956), the Brown-Holtzman Survey of Study Habits and Attitudes (Brown and Holtzman, 1966), a forty-six item questionnaire designed to tap concentration difficulties and coping skills, and a twelve item learning attitude inventory designed to assess students' perceptions of their own academic abilities.

Procedure

For the Comprehension/Retention experiment the three measures were administered to the class members and the "comprehension/retention" controls before the course began (the pre test) approximately halfway through the course (the mid-course test), and after the course was completed (the post test). The first test occurred prior to the beginning of course instruction, consequently it served as a baseline for the analysis of "change" scores on the subsequent tests. For the second test the 25 class members who could attend the study and testing sessions were subdivided into two groups: those that studied for the test individually (N=18) and those that studied in pairs (N=7, there were originally 8 people in this group but one was unable to take the test). For the final testing the 36 participating class members were subdivided into three groups depending on the comprehension/retention sub-strategy being employed: paraphrase/imagery (N=12), key ideas (N=12) or networking (N=12).

For the self-report experiment the four measures were administered to the class members and the "self-report" controls before (pre) and after (post) the course.

Class members were given approximately 2 1/2 hours of training each week for twelve weeks. The two control groups were not given any training during this time period.

The strategy components described earlier in this report formed the basis of the strategy class training. In general, we attempted to intermix the training on primary and support strategies in order to illuminate the interactions between the components. A more detailed description of the sequence of instruction and assessment is presented in Appendix B.

Within a specific class period we attempted to vary the methods of training. Most classes contained a mixture of short lectures, practice exercises and small group or pair discussions. Generally we followed the training approaches outlined in an earlier section of this report (The General Approach: Strategy Training).

We were fortunate to have ten upper level students assisting with the class instruction. Therefore, we were able to give the class members substantial amounts of individual attention and as a result we gained a large amount of "clinical-like" data from the students.

In addition to the within class activities the students in the course were asked to practice their strategies in preparing for other courses. In essence, the students were strongly encouraged to incorporate the strategies into their normal studying. In this regard we instructed the students to try on these strategies in much the same way they would try on a suit or a dress: seeing where they didn't fit and modifying them accordingly. After training on each component was completed the students were asked to evaluate both the training and strategy. This coupled with observational data gathered by the instructors provided a strong basis for subsequent modifications of the strategy training program.

Results and Discussion

The comprehension/retention and self report results will be presented separately.

Comprehension/retention. Each of the three comprehension/retention tests (pre, mid-course, and post) contained both multiple choice and short answer sub-tests. All tests were scored without knowledge of the subject's group affiliation and the raw scores were then converted to percentages of the maximum possible on each test.

The overall treatment (strategy training) versus control differences will be presented first. The means and standard deviations of the total scores and changes in total scores for the comprehension/retention tests are presented in Table 1 (the sample sizes in this and subsequent comprehension/retention tables vary depending on the number of subjects participating in each testing). As can be seen in this table there were slight differences in the pre test means. This situation also occurred with the other dependent measures, consequently all analyses were performed on changes from the pre test base lines. Analysis of the mean changes in total scores indicated that in comparison to the comprehension/retention control group the strategy class members exhibited significantly

Table 1

Means and Standard Deviations of the Total Scores (expressed in terms of percent correct) and Changes in Total Scores for the Comprehension/ Retention Tests

	Pre-Test	Mid-Course	Post-Test	Change from Pre to Mid-Course for Those Participants taking Both Tests	Change from Pre to Post for Those Participants taking Both Tests
Class Members	$\bar{x}$ = 49.28 S = 12.86 N = 36	$\bar{x}$ = 49.73 S = 14.49 N = 25	$\bar{x}$ = 53.27 S = 19.22 N = 36	$\bar{x}$ = .79 S = 10.70 N = 25	$\bar{x}$ = 3.99 S =13.41 N = 36
Comprehension/ Retention Control Group	$\bar{x}$ = 47.38 S = 16.18 N = 28	$\bar{x}$ = 42.29 S = 19.96 N = 28	$\bar{x}$ = 46.72 S = 19.74 N = 23	$\bar{x}$ = -5.09 S = 11.83 N = 28	$\bar{x}$ = -1.81 S = 10.44 N = 23

greater positive change from the pre test to the mid-course test ($t = 1.85$ (51 df), $p < .05$) and from the pre test to the post test ($t = 1.73$ (57 df), $p < .05$). The negative change scores exhibited by the control group indicate that the mid-course test was more difficult than the post test which in turn was more difficult than the pre test (see Table 1). This ordering was supported by subjective ratings of comprehensibility elicited from the subjects at each testing.

The means and standard deviations of the short answer scores and changes in the short answer scores for the comprehension/retention tests are presented in Table 2. Analyses of the mean changes in short answer scores indicated that the class members exhibited a significantly greater positive change from the pre test to the post test than did the comprehension/retention controls ($t = 1.69$ (57 df), $p < .05$). Although the class members mean short answer change from the pre to mid-course test was more positive than that of the controls, the difference did not reach significance ($t = 1.13$ (51 df), $p < .13$). As with the total scores the negative changes exhibited by the controls indicate that the mid-course short answer sub-test was more difficult than the post sub-test which was in turn more difficult than the pre sub-test (see Table 2).

Table 3 contains the means and standard deviations of the multiple choice scores and changes in multiple choice scores. Compared to the Comprehension/Retention controls the strategy class members exhibited significantly greater positive multiple choice changes from pre test to mid-course test ($t = 1.78$ (51 df), $p < .05$). Class members showed more positive mean multiple choice change from pre to post than did the controls, but the difference in change scores did not reach significance ($t = .833$ (57 df), $p < .21$). Examination of the control group's change scores indicates that the mid-course and post multiple choice sub-tests were approximately equal in difficulty and both were more difficult than the pre sub-test (see Table 3).

Table 2

Means and Standard Deviations of the Short Answer Scores (expressed in terms of percent correct) and Changes in Short Answer Scores for the Comprehension/Retention Tests

	Pre-Test	Mid-Course	Post-Test	Change from Pre to Mid-Course for Those Participants taking Both Tests	Change from Pre to Post for Those Participants taking Both Tests
Class Members	$\bar{x}$ = 39.88 S = 16.63 N = 36	$\bar{x}$ = 38.97 S = 16.35 N = 25	$\bar{x}$ = 48.45 S = 24.59 N = 36	$\bar{x}$ = -.55 S = 17.23 N = 25	$\bar{x}$ = 8.57 S = 20.22 N = 36
Comprehension/ Retention Control Group	$\bar{x}$ = 36.61 S = 18.92 N = 28	$\bar{x}$ = 31.32 S = 21.07 N = 28	$\bar{x}$ = 37.46 S = 26.38 N = 23	$\bar{x}$ = -5.29 S = 12.54 N = 28	$\bar{x}$ = -.38 S = 18.31 N = 23

Table 3

Means and Standard Deviations of the Multiple Choice Scores (expressed in terms of percent correct) and Changes in Multiple Choice Scores for the Comprehension/Retention Tests

	Pre-Test	Mid-Course	Post-Test	Change from Pre to Mid-Course for Those Participants taking Both Tests	Change from Pre to Post for Those Participants taking Both Tests
Class Members	$\bar{x}$ = 60.56 S = 12.93 N = 36	$\bar{x}$ = 63.45 S = 14.07 N = 25	$\bar{x}$ = 58.28 S = 16.34 N = 36	$\bar{x}$ = 3.22 S = 11.07 N = 25	$\bar{x}$ = -2.28 S = 13.12 N = 36
Comprehension/ Retention Control Group	$\bar{x}$ = 61.31 S = 15.49 N = 28	$\bar{x}$ = 56.28 S = 21.63 N = 28	$\bar{x}$ = 56.35 S = 15.41 N = 23	$\bar{x}$ = -5.03 S = 17.02 N = 28	$\bar{x}$ = -5.02 S = 10.33 N = 23

The amounts (expressed in percentages) by which strategy class members outscored the control group on each of the comprehension/retention tests are presented in Table 4 (only participants who took all three tests are included in the data display). The data in this table further illustrates the effectiveness of the strategy training; the class members outscored the control group by greater percentages on the mid-course (19.93%) and post tests (18.19%) than on the pre test (3.42%). Further, it appears that the training had a greater influence on the short answer sub-test than on the multiple choice sub-test. On the short answer pre test the class members outscored the controls by 8.14% while on the mid-course and post tests they outscored the controls by 30.15% and 31.02%, respectively. With the multiple choice portion the class members performed .10% lower than the controls on the pre tests while on the mid-course and post tests they outscored the controls by 12.83% and 9.28% respectively. The relatively greater impact of training on the short answer sub tests is especially encouraging since these tests are much less likely to be influenced by guessing and differential test taking strategies than the multiple choice tests.

The data presented in Table 4 suggest that the major effects of the strategy training occurred prior to the mid-course test (the percentages by which the class members outscored the controls are at or near their peaks for each of the measures at the time of the mid-course test). Although this is a teneable hypothesis there are other factors which could have influenced these results. First, as has been stated earlier the mid-course test appeared to be more difficult than the post test (i.e., the control group's changes from the pre-test were more negative with the mid-course than with the post test; further, this ordering was supported by subjective ratings elicited from the subjects). It is possible that the strategy training has a greater impact on more difficult materials thus producing the results exhibited in Table 4. Second, during the training subsequent to the mid-course test and prior to the post test the class members were sub-divided into three groups and each group was trained on a different analytic comprehension/retention

Table 4

The Percentage Amounts by which the Strategy Class Members Outscored the Control Group on each of the Comprehension/ Retention Tests : Mean Differences between the two Groups expressed as percentages of the Control Group's Mean Scores

Pre-Test			Mid-Course Test			Post-Test		
Short Answers	Multiple Choice	Total	Short Answers	Multiple	Total	Short Answers	Multiple Choice	Total
8.14	-.10	3.42	30.15	12.83	19.93	31.02	9.28	18.17

[Only Participants who took all three tests are included in this data summary : class member N = 24 Comprehension/ Retention Control N = 23]

technique: paraphrase/imagery, key ideas and networking. Further, members of these groups were strongly encouraged to use these techniques in studying for the post test. If one or more of these techniques were not as effective (at the time of testing) as the more global stragey (i.e., MURDER with free recitation) taught prior to the mid-course test (see Appendix B) then the data in Table 4 would not be unexpected. This last possibility will be explored in the following paragraphs.

Between the mid-course and post test the strategy class was divided into three groups based on their stated preference for a particular comprehension/retention sub-strategy (the sub-strategies were described and the students rated them in accord with their preference). Each group received approximately 4 hours of training on one of the following strategies: Paraphrase/Imagery, Key Ideas or Networking (see Appendix B). At the time of post assessment students were strongly encouraged to use the sub-strategies they had received. A comparison between these groups indicated that there were no significant differences between the "change" scores from the pre to post test (each group had an N=12). However, Table 5 does indicate that there were substantial differences in the percentage amounts by which these groups outscored the control group. For example, on the short answer sub-tests the Networking group performed 1.16% below the controls on the pre test and 42.26% above the controls on the post test. For the other two groups the differential was substantially less (5.39% above on the pre and 16.36% above on the post for Paraphrase/Imagery and 11.95% above on the pre and 29.42% above on the post for the Key Ideas group).

Table 6 provides data for the strategy sub-groups on all three tests. Again, the percentage amounts by which these groups outscored the control group are illustrated (note: the lack of congruence with Table 5 is due to the reduction of the group Ns necessitated by the fact that we

Table 5

The Percentage Amounts by which the Strategy Sub-Groups Outscored the Control Group on the Pre and Post Comprehension/ Retention Tests : Mean Differences between the Strategy Sub-Groups and the Control Group expressed as percentages of the Control Group's Mean Scores.

	Pre-Test			Post-Test		
	Short Answer	Multiple Choice	Total	Short Answer	Multiple Choice	Total
Paraphrase/ Imagery (N = 12)	5.39	1.35	3.03	16.36	7.67	11.22
Key Ideas (N = 12)	11.95	-1.08	4.47	29.42	2.34	13.40
Networking (N = 12)	-1.16	-4.17	-2.88	42.26	.27	17.42

Table 6

The Percentage Amounts by which the Strategy Sub-Groups Outscored the Contro. Group (N = 23) on each of the Comprehension/ Retention Tests : Mean Differences between the Strategy Sub-Groups and the Control Group expressed as percentages of the Control Group's Mean Scores.

	Pre Test			Mid-course Test			Post Test		
	Short Answer	Multiple Choice	Total	Short Answer	Multiple Choice	Total	Short Answer	Multiple Choice	Total
Paraphrase/ Imagery (N = 8)	6.35	-1.14	2.06	19.48	14.11	16.35	7.47	9.24	8.57
Key Ideas (N = 8)	15.61	3.58	8.87	44.81	14.81	27.01	46.40	14.92	27.84
Networking (N = 8)	2.65	-2.93	-.41	26.62	9.52	16.35	38.67	3.91	22.48

↑

Paraphrase/Imagery, Key Ideas and Networking training occurred between the mid-course and post tests.

have included in Table 6 only those participants that took all three tests). It is particularly instructive to look at the changes in percentages from the mid-course to the post test. On the total score the Networking group (N=8) outscored the control group by 16.35% on the mid-course test and by 22.48% on the post test, the Key Ideas group (N=8) outscored the control groups by 27.01% on the mid-course and 27.84% on the post (please note the pre test percentages), and the Paraphrase/Imagery group (N=8) outscored the control group by 16.35% on the mid-course and by only 8.57% on the post. In other words the Networking group increased its advantage over the controls from mid-course to post while the Key Ideas groups maintained approximately the same advantage and the Paraphrase/Imagery group decreased its advantage. Therefore it is reasonable to speculate that the peak in class-control differences at the midcourse examination may be due to the lack of impact of the Key Ideas training and the apparent negative impact of the Paraphrase/Imagery training. The only group that seemed to benefit from the sub-strategy training was the Networking group. Consequently, if all class members were taught Networking then one would expect that the class-control differences would have been greater on the post test than on the mid-course test (note: it is also possible that the utilization of equally difficult mid-course and post tests would influence the results in the same way). Based on the data presented in Table 5 and 6 we have decided to focus our future research and development efforts on the Networking sub-strategy.

The reasons for the negative impact of the Paraphrase/Imagery training on post test performance are not readily apparent; especially in light of prior work with versions of this technique (e.g. Dansereau, et al, 1975). There are two possible explanations. First, evaluators of paraphrasing and imaging have typically used shorter materials (generally passages of 1,000 words or less; in this study the passages were approximately 3,000 words in length). Because these techniques do not emphasize organization of the material they may be relatively ineffective with longer passages. Second, students chose which type of training they would receive. The Paraphrase/Imagery technique was undoubtedly perceived as the easiest technique to learn and implement, consequently it may have attracted relatively unmotivated students. Their

performance on the post test may be more reflective of motivational deficits than strategy deficits. Although we plan to explore both of these possibilities in future studies they will not be in the mainstream of our research program.

There is one final substrategy comparison of interest. For the mid-course comprehension/retention assessment the class was divided into two groups: those that studied individually (N=18) and those that studied in pairs (N = 7, one of the 8 students originally assigned to this condition was unable to take the test) All students had experience working in pairs during the training prior to the mid-course examinations. Those 8 students who rated their pair experiences most positively were assigned to this group. Although our main interest was in the effectiveness of the strategies as applied by individuals we did want to determine if the MURDER executive routine would be useful in guiding pair interaction. In part, this comparison was designed to extend prior work indicating the potential effectiveness of learning dyads (e.g., Schmerhorn, Goloschmid & Shore, 1975).

An analysis of the changes from pre to mid-course indicated that there were no statistically significant differences between the performance of pairs and individuals, although the pairs on the average, produced more positive "change" scores than did the individuals. (Total change from pre to mid-course equaled +3.9 for the pairs, -.4 for the class members studying individually and -5.1 the controls.) The small sample size for the "pair" group (N = 7) probably reduced the possibilities for significance.

Table 7 presents further information concerning the performance of class members who studied in pairs and as individuals for the mid-course test. The percentage amounts by which these two groups outscored the control group on the pre and mid-course tests are illustrated in this table. These data further illustrate the apparent advantage of pair studying over individual studying. As a consequence of these results we are planning on conducting additional studies to explore the impact of pair learning.

Table 7

The Percentage Amounts by which the class members who studied in Pairs and Individually for the Mid-Course Test outscored the Control Group (N = 23) on each of the Comprehension/ Retention Tests : Mean Differences between the Strategy Class Groups and the Control Group expressed as percentages of the Control Group's Mean Scores.

	Pre-Test			Mid-Course Test		
	Short Answer	Multple Choice	Total	Short Answer	Multiple Choice	Total
Students who studied in Pairs for the Mid-Course Test (N = 7)	16.40	-6.51	3.09	45.45	15.52	27.73
Students who studied Individually for the Mid-Course Test (N = 18)	0.00	0.00	0.00	19.16	10.41	13.98

Self-Report Measures. The self-report measures were scored according to pre-determined keys and a total score was created for each individual on each test. The pre, post and "change" (from pre to post course administration) score means and standard deviations for the four self report measures are presented in Table 8. The different sample sizes reflected in Table 8 are a consequence of the fact that uncompleted self report inventories were not scored. Because there were initial mean differences between the two groups of participants all statistical analyses were performed on the mean changes from pre to post administrations.

One tailed t tests comparing the pre to post change scores of class members with those of the controls reached significance on three of the measures and approached significance on the fourth: Survey of Study Habits and Attitudes ($t=2.57$ (39DF), $p<.01$), The Test Anxiety Scale ($t=2.60$ (45DF), $p<.01$), the Learning Attitude Inventory ($t=3.57$ (48DF), $p<.01$) and the Concentration Questionnaire ($t=1.55$ (44DF), $p<.06$). In all cases the class members reported greater positive changes on academically related dimensions than did the self report controls.

However, these results may have been confounded by either or both of the following factors. Because the class members were generally lower than the controls on the pre measures, the significant effects may have been due to "regression toward the mean." The power of this type of explanation is substantially diminished in this case because previous administrations have shown that these four measures are very reliable. In addition, on the Survey of Study Habits and Attitudes the class members scored below controls on the pre test and above this group on the post test. This result would not be expected if the only factor operating was "regression toward the mean."

Another potential explanation for the results is that the class members may have been "yea saying" on the post measures. The fact that the class members did not show significant changes on some of the items on these scales reduces the possibility the the group's responses to the post measures were artifactual.

Table 8

Means and Standard Deviations of the Pre, Post, and Change scores for the Four Self Report Measures.

	Brown-Holtzman Survey of Study Habits and Attitudes			Modified Test Anxiety Scale (Lower Scores indicate less anxiety)		
	Pre-course	Post-course	Change from Pre to Post	Pre-course	Post-course	Change from Pre to Post
Strategy Class Members	$\bar{x}$=24.7 s=10.3 n=25	$\bar{x}$=29.9 s=11.1 n=25	$\bar{x}$=5.2 s=6.3 n=25	$\bar{x}$=85.6 s=21.8 n=33	$\bar{x}$=71.13 s=22.3 n=33	$\bar{x}$=-14.3 s= 19.6 n= 33
Self-Report Controls	$\bar{x}$=27.0 s= 9.5 n=16	$\bar{x}$=26.7 s= 9.3 n=16	$\bar{x}$=-.3 s=6.9 n=16	$\bar{x}$=69.3 s=16.5 n=14	$\bar{x}$=69.8 s=20.6 n=14	$\bar{x}$= .5 s=10.8 n=14

Table 8 (Continued)

	Concentration Questionnaire			Learning Attitude Inventory		
	Pre-course	Post-course	Change from Pre to Post	Pre-course	Post-course	Change from Pre to Post
Strategy Class Members	$\bar{x}$=174.0 s= 37.7 n= 34	$\bar{x}$=188.4 s= 31.7 n= 34	$\bar{x}$=14.3 s=27.5 n=34	$\bar{x}$=-8.3 s=10.9 n=34	$\bar{x}$= -3.2 s= 11.8 n=34	$\bar{x}$= 5.11 s= 7.0 n=34
Self-Report Controls	$\bar{x}$=205.0 s= 39.8 n= 12	$\bar{x}$=204.8 s= 31.1 n= 12	$\bar{x}$= -.2 s=26.9 n=12	$\bar{x}$= -.4 s=10.9 n=16	$\bar{x}$= -2.8 s= 11.8 n=16	$\bar{x}$=-2.4 s= 6.2 n=16

Although the confounding factors cited above cannot be completely discounted, it seems very likely that the learning strategy training had a positive influence on the academic behavior and attitudes reflected in the four self report measures. Because the sample sizes were relatively small (especially in the case of the control group) subsequent studies will be designed to replicate these results. In these studies an attempt will be made to create control groups with pre means equal to those of the strategy groups in order to eliminate potential confoundings due to regressions toward the means.

CONCLUSIONS AND FUTURE DIRECTIONS

The comprehension/retention and self-report results coupled with the positive feedback arising from the students' course evaluations would indicate that the strategy system and training were impactful in constructively altering the students' learning behaviors and attitudes. It is difficult, however, to determine from this data what aspects of the strategies and training were most responsible for the positive changes. The most salient possibilities along this line are student interactions during studying (pair learning) and the use of the networking technique. As indicated in the results and discussion section, students using these strategies appeared to achieve higher levels of performance on some aspects of the dependent measures than did students using other techniques.

In addition to the formal assessments, participants in the strategy training program were also asked to informally rate the perceived value of each strategy component and to make suggestions for improvement. Although all components used were rated positively, networking, pair learning, concentration management and the MURDER executive routine received the highest ratings. The impact of these highly rated aspects of the program will be explored individually in a series of studies.

Even though the program was generally successful, suggestions by the participants and observations by the instructors during the conduct of the course has indicated a number of directions for improving both the strategies and training methods. Since the conclusion of the course we modified and streamlined the set of components and are in the process of administering them in the context of intensive workshops. Our ultimate goal is a 15 hour modularized training system that is substantially instructor-independent.

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APPENDIX A

The M.U.R.D.E.R. Process: A
Comprehension/Retention
Executive Routine

MURDER : SIX EASY STEPS TO BECOME AN OVERPOWERING LEARNER

MOOD	(1) GET YOURSELF IN THE MOOD FOR LEARNING.
UNDERSTAND	(2) READ FOR UNDERSTANDING.
RECALL	(3) CLOSE THE BOOK AND RECALL AS MUCH OF THE MATERIAL AS YOU CAN.
DIGEST	(4) OPEN THE BOOK AND RE-PROCESS THE MATERIAL IN ORDER TO DIGEST IT.
EXPAND	(5) EXPAND AND DEEPEN YOUR UNDERSTANDING AND YOUR ABILITY TO RECALL BY ASKING QUESTIONS.
REVIEW YOUR TEST MISTAKES	(6) AFTER TAKING A TEST REVIEW YOUR MISTAKES.

MURDER : SIX EASY STEPS TO BECOME AN OVERPOWERING LEARNER

(Inhale textbooks in a single breath, crush professors with clever insights, and destroy tests with your burning intellect!)

MOOD (1) GET YOURSELF IN THE MOOD FOR LEARNING. HOW?

(a) Find a good TIME (SCHEDULING).

(b) Find a good PLACE (THE HANDWRITING IS ON THE WALL).

(c) Clear your MIND (DON'T DRAG IN THE KITCHEN SINK).

AND

(d) Think positively about what you are going to be doing (IF YOU CAN TALK YOURSELF OUT OF STUDYING, YOU CAN TALK YOURSELF INTO IT).

UNDERSTAND (2) READ FOR UNDERSTANDING.

(a) NOTE difficult places in the material.

(b) Don't worry about trying to remember the material or trying to totally understand difficult portions; following the author's main train of thought is all that is needed at this stage. (SEE THE AUTHOR AS A TOUR GUIDE).

(c) "SPICE" UP THE MATERIAL YOU ARE READING (FORM PICTURES, GET EXCITED, MAKE JOKES).

NOTE: Stop reading after 10-20 minutes or 5-10 pages or when the author shifts topics. This is your PERSONAL decision and is something you will have to EXPERIMENT with in order to decide on the optimal amount to do before stopping.

RECALL (3) CLOSE THE BOOK AND RECALL AS MUCH OF THE MATERIAL AS YOU CAN.

(a) You can write it down (perhaps on the "Free Recall" Worksheet), say it into a tape recorder, or say it to a friend.

(b) To help you recall, use the "Positive Suggestions" on pages 12 and 13 of your "Understanding and Recall" Booklet:

(i) RELAX (Breathing, Muscles, Fantasy).

(ii) IMAGE yourself back in the learning situation

(iii) See if the information relates to something you already know.

(iv) Go back over what you have already recalled to give yourself more ideas

(c) Congratulate yourself on your recall successes.

DIGEST (4) OPEN THE BOOK AND RE-PROCESS THE MATERIAL IN ORDER TO DIGEST IT.

(a) Pay particular attention to the material you didn't recall and the material you didn't understand on your first reading.

(b) Use the methods for solving understanding problems where appropriate (See booklet on solving problems in comprehension if necessary):

(i) IDENTIFY the source of the problem (Word, Sentence, Paragraph, Passage).

(ii) BREAK the problem down into its parts, look at the SURROUNDING information, and go to ANOTHER SOURCE if necessary.

(iii) Make your BEST GUESS.

EXPAND

(5) EXPAND AND DEEPEN YOUR UNDERSTANDING AND YOUR ABILITY TO RECALL BY ASKING QUESTIONS. (See pages 18 and 19 of the "Understanding and Recall" booklet).

(a) Imagine that you could talk to the author. What questions would you ask?

(b) What can the material be used for?

(c) How could you make the material more understandable and interesting to other students?

REVIEW YOUR TEST MISTAKES

(6) AFTER TAKING A TEST REVIEW YOUR MISTAKES. (See "How to Learn from a Test" booklet)

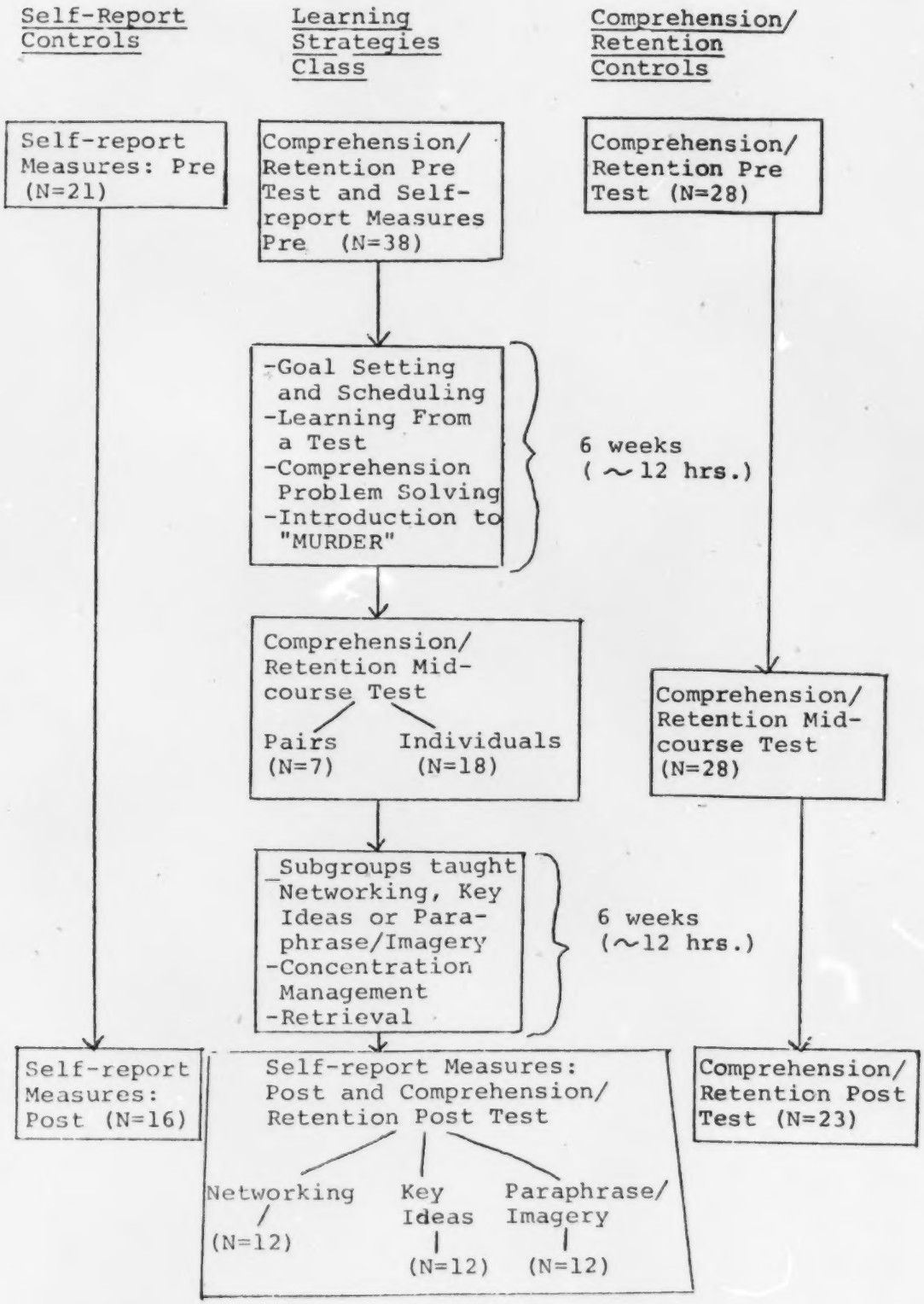
(a) Identify the types of questions you had trouble with.

(b) Locate the source of your difficulty.

(c) Decide on a way of guarding against the same mistakes in the future.

APPENDIX B

Schedule of Activities



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